

APPLICATION NOTE 4566

Extending the Input Voltage Range of Standard Op Amps

Abstract: Using its own output to bootstrap a low-dropout voltage regulator (MAX6771) with high input-voltage range (up to 76V), this circuit extends the input range of a CMOS op amp (MAX4162) while preserving its high input impedance and very low input bias current ($< 1\text{pA}$).

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Most modern operational amplifiers operate over a 5V (or $\pm 2.5\text{V}$) or lower voltage range. For applications requiring a larger voltage swing, such as industrial circuits, suitable high-voltage operational amplifiers can be expensive and may not be readily available. The circuit of Figure 1 can extend that range. It operates as a voltage follower, keeping the very high input impedance of a CMOS op amp, and excellent linearity and stability over a much wider voltage range.

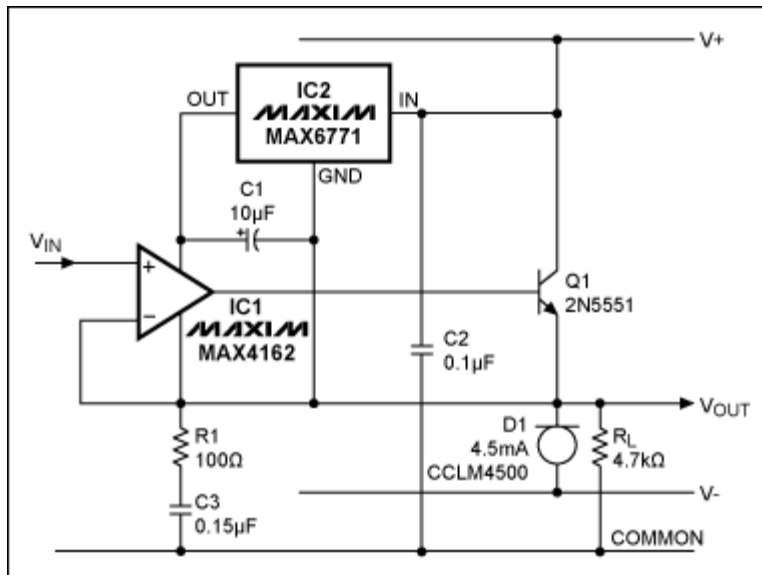


Figure 1. By leveraging a low-dropout regulator, this voltage follower can achieve an extended voltage swing.

The circuit uses its own output to bootstrap a high-input-voltage-range (up to 76V), low dropout voltage regulator (LDO) whose output is connected to the supply lines of the low voltage input op amp. The circuit exhibits the high impedance, very low bias current input of a CMOS amplifier ($< 1\text{pA}$ input current). Linearity is better than 1ppm over a $\pm 20\text{V}$ voltage range, when supplied by $\pm 24\text{V}$ ($V+$, $V-$), and the input offset magnitude and thermal drift is the same as the amplifier used at the input. The graph in Figure 2 shows the output of the voltage follower with a 400Hz, $20\text{V}_{\text{P-P}}$ triangle wave applied at the input.

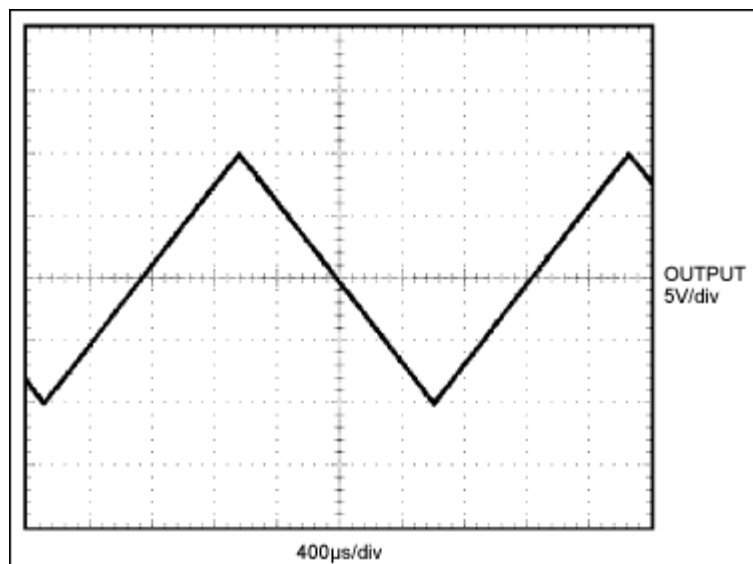


Figure 2. Voltage-follower output for a 400Hz triangle-wave input.

IC1 ([MAX4162](#)) is a micropower, precision op amp with a gain bandwidth product of 200kHz. IC2 ([MAX6771](#)) provides a regulated +3.3V supply voltage to IC1. The common node of IC2 is tracked to the input voltage by the feedback loop comprised of IC1 and transistor Q1. D1, a 4.5mA constant-current diode, provides quiescent biasing current for Q1, and sinks current from the load when V_{IN} is below circuit common potential. The RC network R1 and C3 provide shunt compensation to stabilize the circuit for a given bias current through Q1.

Output voltage swing is limited by the headroom requirements of the LDO and the constant current biasing diode, D1. The MAX6771 input voltage range of 76V and the maximum voltage rating of Q1 limit the allowable output voltage range of the circuit.

Related Parts

[MAX4162](#) SOT23, Micropower, Single-Supply, Rail-to-Rail I/O Op Amps -- [Free Samples](#)

[MAX6771](#) Automotive Micropower Linear Regulators with Supervisor

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